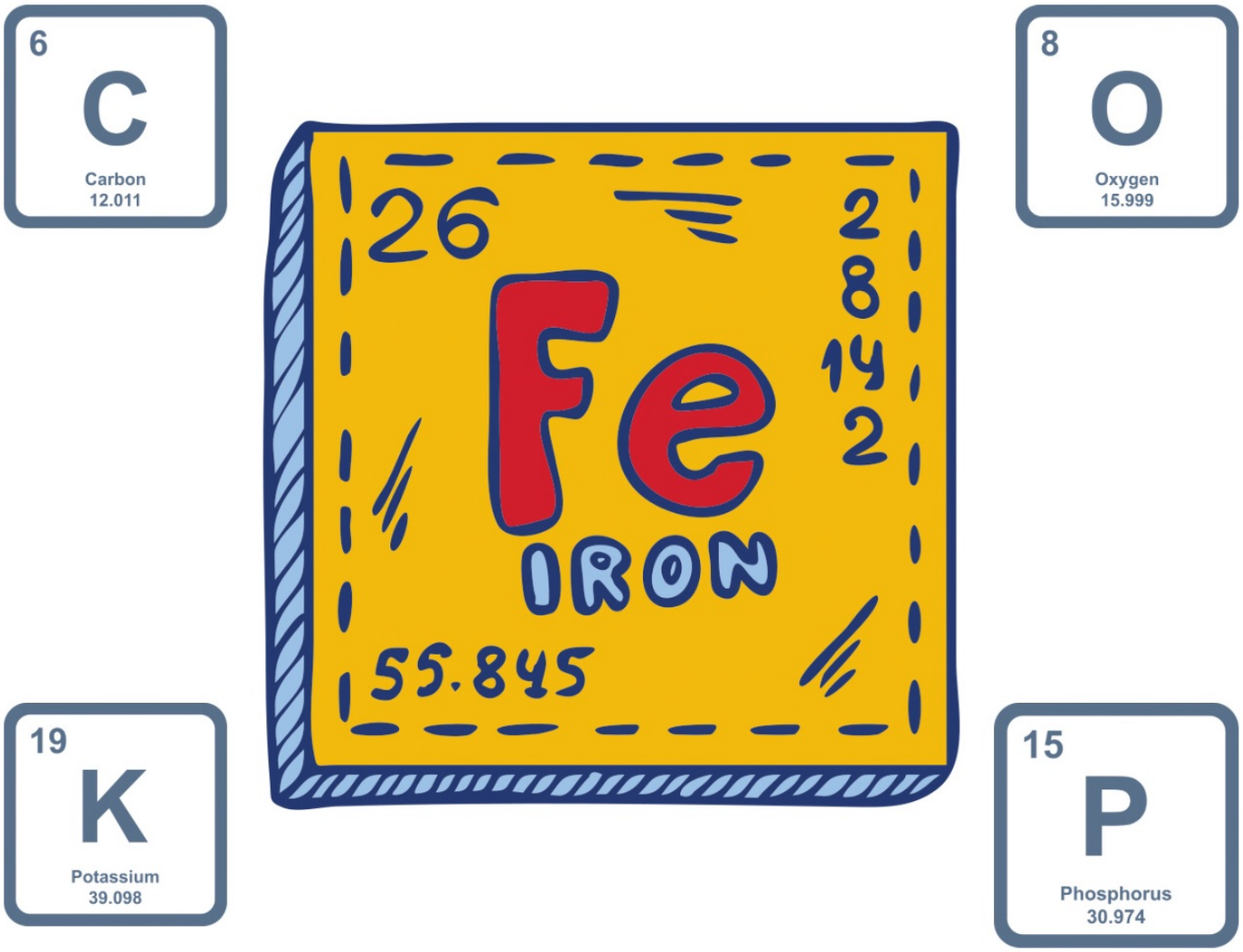
Periodic Classification of Elements

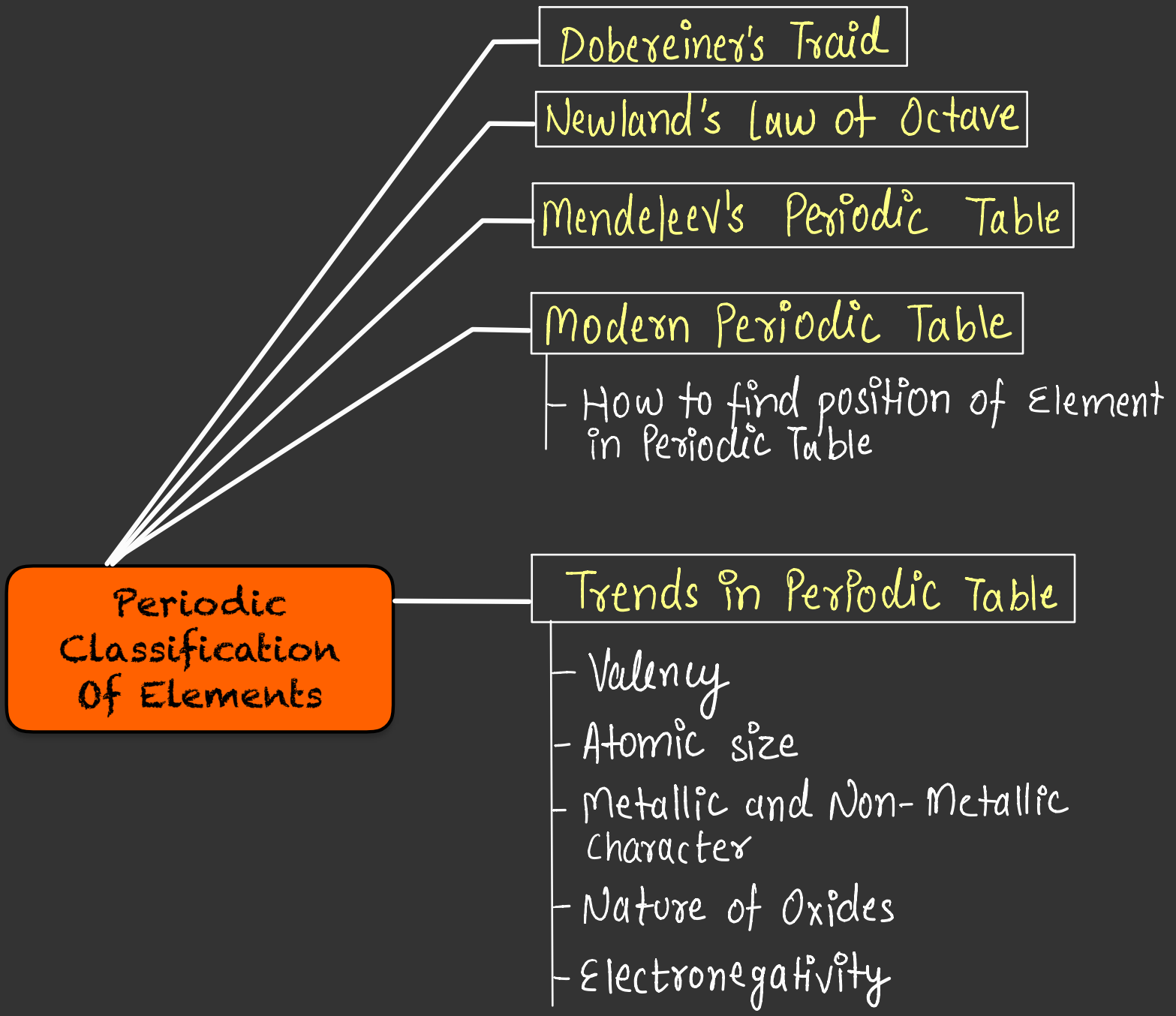
HANDWRITTEN NOTES

[Prv. Years Included]



Designed With ♥

Shobhit Nirwan


Periodic Classification Of Elements
Dobereiner's Traid
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Valency
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SUPER TIP: STORY की तरह पढ़ना इन्हें!

- At present, there are 118 elements known, out of which 98 are naturally occuring.
- All the elements have been divided into few groups in such a way that elements in the same group have similar properties of elements.

अब हम वेही सब discuss करेंगे कि scientists ने क्या क्या Attemps करे, elements को classify करने के लिए।

DOBEREINER'S TRIADS

- In 1817, Johann Wolfgang Döbereiner tried to arrange the elements with similar properties into groups.
- He identified some groups having three elements each, so he called these groups 'triads'.
- When the three elements in a triad were written in the order of increasing atomic masses, the atomic mass of the middle element was roughly the average of the atomic masses of the other two elements.

eg

Elements	Cl Br I	Li Na K	Ca Sr Ba
At. Mass	35.5 80 127	7 23 39	40 88 137
Avg. of first and third	$\frac{35.5+127}{2} \Rightarrow 81.25$	$\frac{7+39}{2} = 23$	$\frac{40+137}{2} = 88.5$

LIMITATIONS:

All the elemements discovered at that time could not be classified into triads. He could identify only three triads. [Cl, Br, I ; Li, Na, K ; Ca, Sr, Ba]

Döbereiner Uncle तो fail हो गए but Newlands' chacha ने इसके बाद एक मस्त idea निकाला! देखते हैं क्या :-

Newlands' Law of Octaves

- In 1866, John Newlands arranged the known elements in the order of increasing atomic masses.
- started from hydrogen and ended at thorium (56th element).
- He found out that every eight element had properties similar to that of the first.

Table 5.3 Newlands' Octaves

sa (do)	re (re)	ga (mi)	ma (fa)	pa (so)	da (la)	ni (ti)
H	Li	Be	B	C	N	O
F	Na	Mg	Al	Si	P	S
Cl	K	Ca	Cr	Ti	Mn	Fe
Co and Ni	Cu	Zn	Y	In	As	Se
Br	Rb	Sr	Ce and La	Zr	—	—

- He compared this to the octaves found in music, i.e. sa, re, ga, ma, pa, da, ni. And in the west, they use the notations – do, re, mi, fa, so, la, ti. Therefore, he called it Law of "Octaves".

LIMITATIONS:

- This law was applicable only upto calcium, after calcium every eight element did not possess properties similar to that of the first
- Newlands assumed no more element would be discoved in the future. But later on, several new elements were discovered who couldn't fit into the Law of Octaves.
- Newlands adjusted two elements in the same slot but also put some unlike elements under the same group.

∴ Newlands' law worked well with lighter elements, पर कहानी यही खत्म नही होती है अभी Mendeleev बाबाजी का आना रहता है।

Mendeleev's Periodic Table

- Dmitri Ivanovich Mendeleev, the most important contributor for the early development of a periodic table of elements wherin the elements were arranged on the basis of their fundamental property, the atomic mass and also on the similarity of chemical properties.
- When he started his work 63 elements were known. He examined the relationship between the atomic masses of the elements and their physical and chemical properties.
- It was also observed that there occurs a periodic recurrence of elements with similar physical and chemical properties.
- On that basis Mendeleev formulated a Periodic Law which states that 'the properties of elements are the periodic function of their atomic masses.'
- Mendeleev's Periodic Table contains vertical columns called 'groups' and horizontal rows called 'periods'.
- Mendeleev left some gaps in the Periodic Table. He boldly predicted the existence of some elements that had not been discovered at that time. Mendeleev named them by prefix 'Eka' to name of preceding element in the same group. Scandium, Gallium & Germanium discovered later have properties similar to Eka-boron, Eka-aluminium, Eka-silicon respectively.
- When inert gases were discovered they could be placed in a new group without disturbing the existing order.

LIMITAION:

- No fixed position can be given to hydrogen in the periodic table.
- Isotopes of all elements posed a challenge to Mendeleev's Periodic Law.
- Atomic masses do not increase in a regular manner in going from one element to next. So not possible to predict how many elements could be discovered between 2 elements.

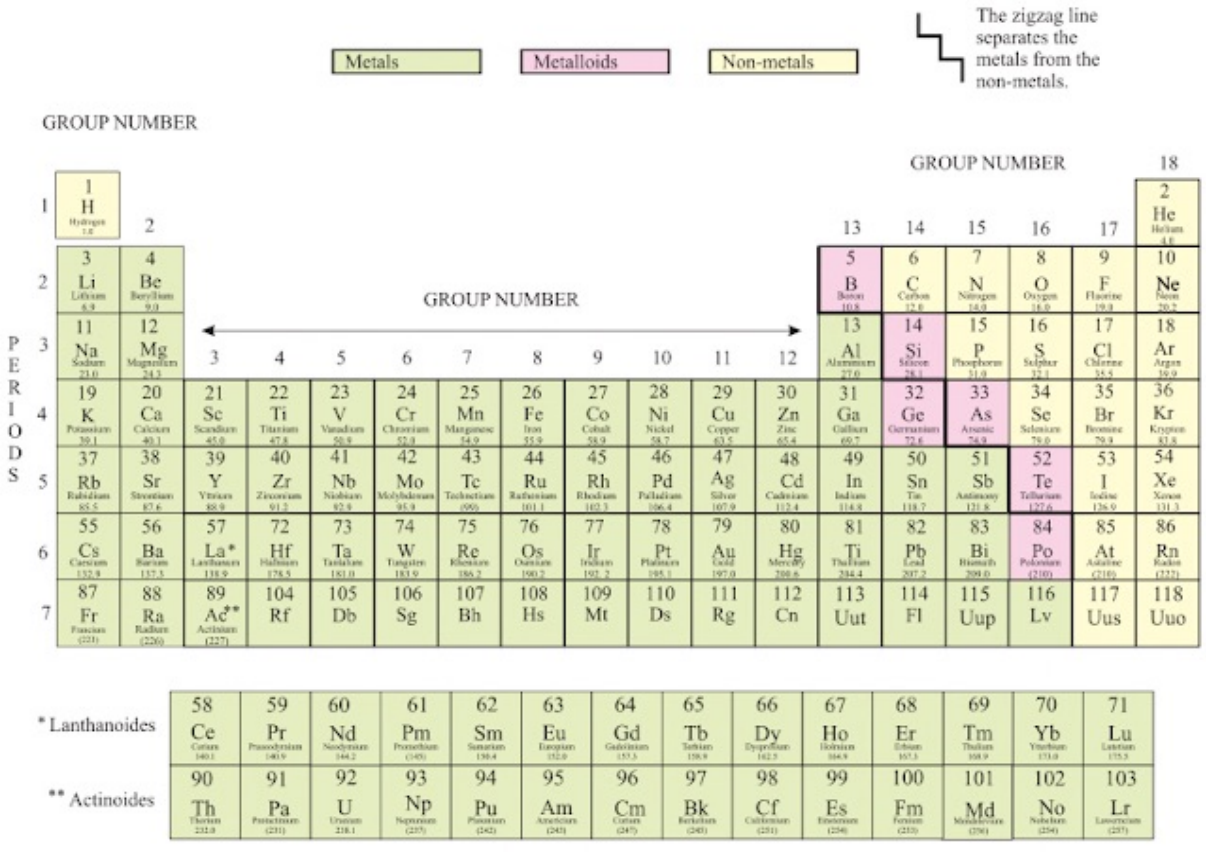
Group	I	II	III	IV	V	VI	VII	VIII
Oxide Hydride	R_2O RH	RO RH_2	R_2O_3 RH_3	RO_2 RH_4	R_2O_5 RH_3	RO_3 RH_2	R_2O_7 RH	RO_4
Periods ↓	A B	A B	A B	A B	A B	A B	A B	Transition series
1	H 1.008							
2	Li 6.939	Be 9.012	B 10.81	C 12.011	N 14.007	O 15.999	F 18.998	
3	Na 22.99	Mg 24.31	Al 29.98	Si 28.09	P 30.974	S 32.06	Cl 35.453	
4 First series:	K 39.102	Ca 40.08	Sc 44.96	Ti 47.90	V 50.94	Cr 50.20	Mn 54.94	Fe 55.85 Co 58.93 Ni 58.71
Second series:	Cu 63.54	Zn 65.37	Ga 69.72	Ge 72.59	As 74.92	Se 78.96	Br 79.909	
5 First series:	Rb 85.47	Sr 87.62	Y 88.91	Zr 91.22	Nb 92.91	Mo 95.94	Tc 99	Ru 101.07 Rh 102.91 Pd 106.4
Second series:	Ag 107.87	Cd 112.40	In 114.82	Sn 118.69	Sb 121.75	Te 127.60	I 126.90	
6 First series:	Cs 132.90	Ba 137.34	La 138.91	Hf 178.49	Ta 180.95	W 183.85		Os 190.2 Ir 192.2 Pt 195.09
Second series:	Au 196.97	Hg 200.59	Tl 204.37	Pb 207.19	Bi 208.98			

(Rattni nahi hai!)

अब entry होगी Legend की → Henry Moseley.

Modern Periodic Table

- In 1913, Henry Moseley showed that the atomic number of an element is more fundamental properly than its atomic mass.
- According to Modern Periodic Law, 'Properties of elements are a periodic function of their atomic number.'
- When the elements were arranged in the increasing order of their atomic number, the obtained table is called Modern Periodic Table.
- It has 18 vertical columns known as 'groups' and 7 horizontal rows known as 'periods'.
- Elements in same group have same number of valence electrons.
- The number of shells increase as we go down the group.
- Elements in same column have same number of shells. The number of valence electrons increases as we move from left to right in a period.



How to find Position of the Elements in Modern Periodic Table :-

First of all, write its electronic configuration and then find period and group number from this electronic configuration in following way :-

- The Period Number of an element is equal to the number of electron shells in its atom.
  eg: if the atom of an element has 2 electronic shells (K and L), then it belongs to 2nd period.
- Don't worry if two (or more) elements have the same number of valence shells, then they belong to same period of periodic table.
- The group number of an element having upto two valence electrons is equal to the number of valence electrons.
  eg: if an element has 1 valence electron, it belongs to group 1. And if an element has 2 valence electrons, it belongs to group 2 of periodic table.
- If more than 2 valence es, the group number is equal to the number of valence electrons plus 10. eg. if an element has 5 valence electrons then its group number will be $5+10 = 15$
- Again, don't worry if two (or more) elements have the same number of valence electrons then they belong to the same group of periodic table.

(K³B) Positions of elements in the periodic table also tells us about their chemical reactivity. If they are present at extreme left or extreme right, they are highly reactive metals or non-metals respectively.

Imp LP: What are the different anomilies of Mendeleev's Periodic Table which can be explained with the help of modern Periodic Table?

ans: (i) Since the fundamental basis for modern periodic table is atomic no., not atomic mass, hence it is more accurate.
(ii) Since, the table is based on atomic number and isotopes have same atomic number and chemical properties, so they can be put at one place in the same group of the periodic table.
(iii) In this periodic table, a unique position has been given to hydrogen. It is kept at the top left corner because of its unique characteristics.
(iv) The position of cobalt and nickel is justified itself because atomic no. of cobalt is less than atomic number of nickel.

Trends in Modern Periodic Table

Valency :-

- It depends upon the number of valence electrons present in the outermost shell of its atom.

- for the elements of group 1, 2, 13, 14, valency = number of valence electron(s), whereas for the elements of group 15 onwards, valency = 8 - valence electrons

Variation along group: In a group, outer electronic configuration is same for all the elements, so all have the same number of valence electrons and the valency. eg. all elements of group 1 have valency = 1.

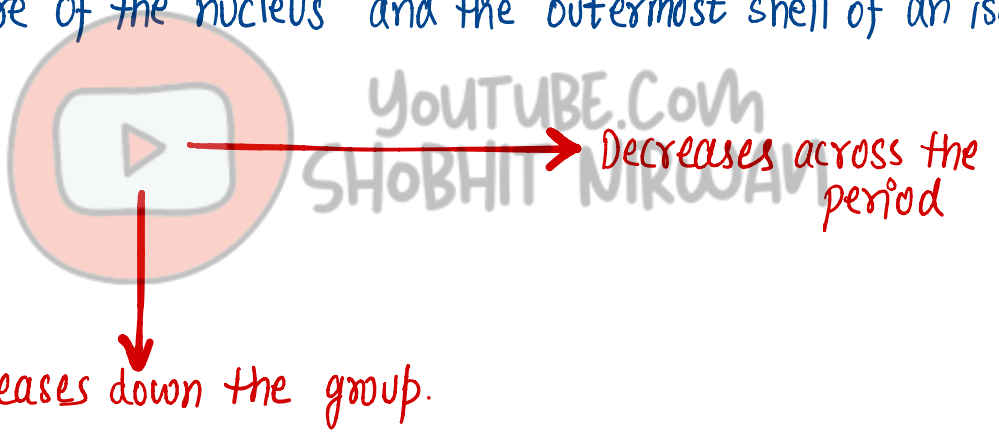
Variation along a period: The valency increases from 1 to 4 (till group 14) and then decreases to zero from group 15 to 18.

Group	1	2	13	14	15	16	17	18
Valency	1	2	3	4	3	2	1	0

Atomic Size

It refers to the radius of an atom. It may be visualised as the distance between the centre of the nucleus and the outermost shell of an isolated atom.

Variation:



Reason for group: New shells are being added as we go down the group. This increases the distance between the outermost electrons and the nucleus.

Reason for period: This is due to an increase in nuclear charge which tends to pull the valence electrons closer to the nucleus and reduces the size of the atom.

Metallic and Non-Metallic character

- Elements having a tendency to lose one or more electrons and form positive ions are called **Metals.** [because +ve ion is formed, ∴ also called electropositive elements].
- Metals are present on the left side as well as in the centre of the Periodic Table.
- The tendency of these elements to lose electrons is called **metallic character.**
- Elements having a tendency to gain one or more electrons to form negative ions are called **Non-Metals.** electronegative elements

Variation

Decreases across period → Metallic character → Increases down the group

Increases across period → Non-metallic character → Decreases down the group.

Reason:
As the effective nuclear charge acting on the valence shell electrons increases across a period, the tendency to lose electrons will decrease.
Down the group, the effective nuclear charge experienced by valence electrons decreases because the outermost electrons are farther away from the nucleus. Therefore, these can be lost easily. Hence, metallic character decreases across a period and increases down a group. Non-metallic character, however increases across a period and decreases down a group.

NATURE OF Oxides

- Oxides of the metals are of basic nature while those of non-metals are acidic.
- Along a period, the basic character of the oxides of the elements decrease while their acidic character increases.
- Going down in a group, the order is reversed i.e. basic character of oxides increases and acidic character of oxides decreases.

Increases → Acidic → decreases

decreases → Basic → increases.

Electronegativity

It is the relative electron attracting tendency of an atom for a shared electron pair in a covalent bond with other atom.

Variation: same as non-metallic character

- Elements exhibiting properties of both Metals and Non-Metals are called Metalloids.

PYQs

2020

3. Answer question numbers 3(a) – 3(d) on the basis of your understanding of the following paragraph and the related concepts.

Around the year 1800, only 30 elements were known, Dobereiner in 1817 and Newlands in 1866 tried to arrange the then known elements and framed laws which were rejected by the scientists. Even after the rejection of the proposed laws, many scientists continued to search for a pattern that correlated the properties of elements with their atomic masses. The main credit for classifying elements goes to Mendeleev for classifying elements goes to Mendeleev for his most important contribution to the early development of a periodic table of elements wherein he arranged the elements on the basis of their fundamental property, the atomic mass and also on the similarity of chemical properties. The format of their hydrides and oxides were treated as basic criteria for the classification of the elements. However, Mendeleev's classification also had some limitations as it could not assign the position to isotopes. He also left some gaps in the periodic table.

3(a). State Mendeleev's Periodic Law
3(b). Why did Mendeleev leave some gap in the periodic table? → Answer In notes
3(c). If the letter 'R' was used to represent and of the elements in the group, then hydride and oxide of carbon would respectively be represented as
(i). RH_4 , RO (ii). RH_4 , RO_2 (iii). RH_2 , RO_2 (iv). RH_2 , RO

3(d) Isotopes are

(i) Atoms of elements with similar chemical properties but different atomic masses.
(ii) Atoms of different elements with similar chemical properties but different atomic masses.
(iii) Atoms of elements with different chemical properties but similar atomic masses.
(iv) Atoms of different elements with different chemical properties but similar atomic masses.

2019

20. Answer the following questions based on the elements with atomic number 3 to 9 :
(a) Name the element with smallest atomic radius. → Fluorine (F)
(b) Name the element which shows maximum valency. → Carbon (C)
(c) Name the element which is a metalloid. → Boron (B)
(d) Name the element which is most electropositive. → Lithium (Li)
(e) Write the chemical formula of the compound formed when the elements of atomic number 6 and 8 react together.

→ The chemical formula of the compound formed when the elements of atomic number 6 and 8 react together CO and CO_2.

2018

17. (a) The modern periodic table has been evolved through the early attempts of Dobereiner, Newland and Mendeleev. List one advantage and one limitation of all three attempts. → In Notes

(b) Name the scientist who first of all showed that atomic number of an element is a more fundamental property than its atomic mass. → Henry Moseley

(c) State Modern Periodic law. → In notes.

2017

9. What is periodicity in properties of elements with reference to the Modem periodic Table? Why do all the elements of the same group have similar properties? How does the tendency of elements to gain electrons change as we move from left to right in a period? State the reason of this change?

ans- Properties which reappear at regular intervals or in which there is gradual variation at regular intervals are called periodic properties and the phenomenon is known as the periodicity of elements. Elements in the same group or column have the same number of electrons in their outermost shell. Hence, elements of the same group have similar properties. On moving across a period from left to right, the tendency to gain $e^{\ominus}$s increases. This is due to an increase in the nuclear pull and a decrease in atomic size.

2016

9. An element 'X' belongs to 3rd period and group 16 of the Modern Periodic Table.

(a) Determine the number of valence electrons and the valency of 'X'.

(b) Molecular formula of the compound when 'X' reacts with hydroger and write its electron dot structure.

(c) Name the element 'X' and state whether it is metallic or non-metallic.

ans, X = 2, 8, 6

(a) Valency = 8 − 6 ⇒ 2

(b) Formula = H_2X

(c) X is sulphur and a non-metal.

10. An element 'X' has mass number 35 and number of neutrons 18 Write atomic number and electronic configuration of 'X'. Also write group number, period number and valency of 'X'.

ans 10: Atomic no.
X = 35 − 18 = 17
Electronic config. ⇒ 2, 8, 7
Group number ⇒ 17
Period number ⇒ 3
Valency ⇒ 1

2015

9. Two elements 'P' and 'Q' belong to the same period of the modern periodic table and are in Group 1 and Group 2, respectively. Compare their following characteristics in tabular form:

(a) The number of electrons in their atoms

(b) The sizes of their atoms

(c) Their metallic character

(d) Their tendencies to lose electrons

(e) The formula of their oxides (f) The formula of their chlorides

10. Taking the example of an element of atomic number 16, explain how the electronic configuration of the atom of an element relates t its position in the modern periodic table and how valency of an element is calculated on the basis of its atomic number.

ans 9:

Property	P	Q
No. of $e^{\ominus}$ in atom	3, 11, 19	4, 12, 20
size of atom	Bigger	smaller
Metallic character	more	less
Tendency to lose $e^{\ominus}$s	more	less
Oxide formula	P_2O	QO
formula of their chlorides	PCl	QCl_2

ans 10: An element whose atomic no. is 16 has the electronic configuration as : 2, 8, 6. It has 6 valence electrons so its valency is 2 and it is positioned in period 3 and group 16.

Valency = 8 − 6 = (2)

2014

36. (a) Define the following terms :

(i) Valency (ii) Atomic size

(b) How do the valency and the atomic size of the elements vary while going from left to right along a period in the modern periodic table?

→ In notes

37. Consider two elements 'A' (Atomic number 17) and 'B' (Atomic number 19) :

(i) Write the positions of these elements in the modern periodic table giving justification.

(ii) Write the formula of the compound formed when 'A' combines with 'B.'

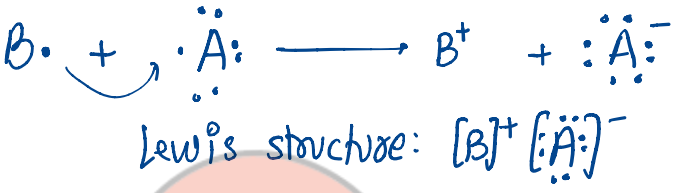
(iii) Draw the electron dot structure of the compound and state the nature of the bond formed between the two elements.

ans 37:-

Element	Period
A	3
B	4

Atomic no. of A is 17.
Electronic config. of A = 2,8,7. Valence $e^{\ominus}$ present in atom A = 7
Valency of A = 8 - 7 = 1
The atomic number of atom B is 19.
Electronic config. of B = 2,8,8,1. Valence $e^{\ominus}$ of B is 1.
Valency of B = 1.

Element B A
Valency 1 1 $\equiv$ BA



Lewis structure: $[B]^{+}[:\ddot{A}:]^{-}$

Bond between A and B is ionic
Generally a metal and non-metal combine by means of ionic bond.